PAPERMAKING REFINER PLATES & METHOD OF MANUFACTURE

FIELD OF THE INVENTION

The present invention relates to refiner plates for papermaking and refining of lignocellulosic and other natural and synthetic fibrous materials in the manufacture of paper, paperboard, and fiberboard products. In particular, the invention relates to replacable refiner fillings and to method of manufacture.

BACKGROUND OF THE INVENTION

In nearly all milled or fabricated refiner plates, and in many cast refiner plates, the working surface of the refiner plate consists of clusters of parallel bars and grooves. The refiner filling disc is normally depicted as a complete circle, but in fact the filling often consists of several more-or-less pie-shaped segments which are much easier to handle when replacing a filling.

United States Patent No. 5,740,972 discloses improvements in replaceable refiner fillings and the manufacture of refiner fillings with working surfaces using relatively narrow, closely spaced bars on the working surface of the plate. The refiner fillings have relatively thin blades separated by shallower spacer bars having a thickness which determines the width of the grooves.

The refiner fillings use a metal or other hard and durable material for the blades and spacers, which blades and spacers are then metallurgically bonded to each other along their entire intercontacting surfaces. A suitable metallurgical bond is achieved through any of several known methods including welding, diffusion bonding, brazing, or any other method which results in a joint strength approaching that of the blade or spacer material. Materials used include stainless steel blades bonded to carbon steel spacers and ceramic and metal composite materials as blade or spacer components in refiner fillings. A metal composite material which exhibits suitable strength and toughness characteristics for a particular refiner application is used for the blades of the filling, while a much less costly material may be used for the spacers.

As disclosed in the '972 patent, segmental replacement disc refiner

plates are produced with segments having both non-circular edges (i.e., side edges) which are not precisely radial. Instead, the side edges are oblique to the precisely radial line such that the refiner plate segmental dividing line is parallel to the adjacent refiner blade. Each segment may typically have a value of 30, 45, or 60 degrees of a circle so that 12, 8, or 6 segments, respectively comprise a refiner disc.

The blades of each cluster are positioned parallel to a side edge of the cluster and extend from the outer periphery toward the inner periphery of the segment. Blade obliqueness to the disc radius increases with distance normal to the side edge. It is desirable with refiner plates to avoid shallow crossing angles (i.e., high degree of obliquity to radial) of stator and rotor blades and therefore desirable to maintain blade obliqueness in a range of 3 to 20 degrees with respect to disc radial. Hence, the blade pattern is begun anew at that location in the refiner segment where increasing obliqueness approaches 20 degrees. So, the segment blade pattern is repeated at intervals to maintain blade obliqueness within a desired range over the entire working surface of a refiner filling. The repeated blade pattern is defined herein as a blade cluster characterized by a common cluster angle throughout the refiner filling.

An obvious method for producing the components of a blade cluster for this type of fabricated refiner plate would consist of cutting individual blades and spacers, such that for any specified set of inside diameter, outside diameter, and cluster angle, each blade and spacer would have a unique length. The uniqueness of each component, and the relative difficulty of fitting them precisely, results in a high cost to manufacture.

The present invention provides refiner fillings of the kind disclosed in the '972 patent and methods for manufacture of the fillings economically and efficiently with very significant reduction in the cost of tools and fixtures while greatly facilitating the assembly of refiner filling clusters. In particular, the invention facilitates the manufacture of refiner fillings in a preferred embodiment having a preferred range of working surface blade obliqueness to disc radial, working surface blades assembled in cluster units conforming to the range of blade obliqueness, a fixed pumping angle, and a fixed number of identical segments comprising a refiner filling.

The invention also provides a barset envelope or parallelogram as defining a basic unit of manufacture of a working surface of blades and spacers, with each barset divisible into two identical blade clusters.

SUMMARY OF THE INVENTION

The present invention provides improvements in replaceable refiner fillings and has as a primary objective the manufacture of refiner fillings with working surfaces using relatively narrow, closely spaced bars on the working surface of the plate. This is accomplished by using relatively thin blades preferably of stainless steel, separated by shallower spacer bars preferably of carbon steel having a thickness which determines the width of the grooves, and subsequently fusing or bonding the assembled blades and spacers into a solid piece by methods appropriate for the blade and spacer materials being used.

In another primary aspect of the invention, the spacers and blades are assembled in bar sets according to a predetermined pattern, bonded together, and with each bar set cut in half to yield identical clusters. A refiner filling segment comprises a plurality of clusters bonded together. In a preferred embodiment, six clusters are assembled in edge to edge relation and bonded to form a filling segment. A complete refiner filling disc in preferred embodiment comprises eight segments.

In a preferred method, a bar set of blades and spacers is the basic unit of manufacture with the bar set configuration or envelope established in a first step. The bar set envelope is a parallelogram with its long edge coincident with a refiner filling segmental edge. The segmental edge is offset from a true radius of the refiner disc as in the '972 patent, and the offset is defined as the pumping angle of the refiner filling. The offset or pumping angle is preferably in a range of 3^0 to 20^0. The pumping angle is also defined as the angle between the first cluster blade and the disc radius, and also as the line between blade clusters.

The number of blades and spacers comprising a bar set is selected so as to yield two identical clusters when the bar set is cut in half. A bar set cutting line is established between opposite outer and inner sides of the bar set parallelogram

for cutting the bar set precisely into matching clusters.

After the bar set parallelogram is defined, blades and spacers are assembled, alternating with each other, all in parallel with the long edges of the parallelogram and of course with the design offset edge of each refiner segment, and are bonded after assembly. Several of the blades lie across the path of the cutting line and are prenotched at their intersection of the cutting line.

After a bar set is cut into two identical bar clusters, one cluster is rotated 180^0 so that its outer long edge abuts the cut edge of the other cluster. A multiple of cut and rejoined clusters are assembled and bonded to form a refiner segment. The completed segment is characterized by an integer multiple of clusters in edge to edge relationship, the first blade of each cluster having the same offset angle as the segmental edge, and the blades of each cluster having the same range of obliquity from the refiner disc radius.

The invention provides for a method of assembling clusters from only a few unique blade and spacer components. In the manufacturing method many of the blades are identical and all spacers are identical to simplify inventory of parts. A complete refiner filling disc may employ approximately 1000 blades and spacers with each bar set component having 18 blades and 19 spacers. The invention results in very significant reduction in the cost of tools and fixtures, and greatly facilitates the assembly of the clusters.

OBJECTS OF THE INVENTION

It is an object of the invention to provide refiner plates and a method for their manufacture.

It is an object of the invention to provide improved refiner plates in which bars and spacers are assembled in proper order and are fused or bonded together.

Another object of the invention is to provide efficient and economical manufacture of refiner fillings with predetermined pattern of blades and spacers.

Other and further objects of the invention will occur to one skilled in the art with an understanding of the following detailed description of the invention or

upon employment of the invention in practice.

DESCRIPTION OF THE DRAWING

A preferred embodiment of the invention has been chosen for purposes of illustrating the construction and operation of the invention and is shown in the accompanying drawing in which:

Figure 1 is a plan view of a refiner filling disc according to the invention.

Figure 2 is a fragmentary section view of a refining filling illustrating the positions of blades, spacers, and base plate.

Figure 3 is a plan view of a refiner filling segment according to the invention.

Figure 4 is a schematic view illustrating the geometric definition of a blade and spacer cluster according to the invention..

Figures 5a-5h are side and end elevational views of blades and spacer according to the invention.

Figure 6 illustrates the outline of adjacent bar set clusters.

Figure 7 illustrates the bar set clusters of Figure 6 re-positioned to form a bar set envelope or parallelogram.

Figure 8 illustrates a bar set of blades and spacers assembled in a bar set envelope.

Figure 9 illustrates the bar set of Figure 8 cut along line C-C, and re-positioned into adjacent bar set clusters ready for assembly into a refiner segment.

Figure 10 is a side elevational view of a bar set cluster along cut line C-C.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawing, a preferred embodiment of a refiner disc filling 10 according to the invention comprises a supporting plate 12 to which blades

14 and spacers 16 are affixed and wherein the blades and spacers define the disc working surface 17 and intervening grooves 18.

As shown in Figures 1, 3 and 4, in a preferred embodiment of the invention, the refiner disc filling 10 has defining margins in outer 20 and inner 22 concentric perimeters. The filling (Fig. 1) comprises a plurality of filling segments A-B, B-C, and C-A with each segment having a plurality of bar clusters 24. The outer and inner perimeter circles define an annular active refining zone 26 containing all the blades and spacers of the filling.

In the filling segment A-B of Figure 3, each bar cluster 24 has an oblique side edge 24a offset from the disc radius R by a specified angle alpha defined as the pumping angle, with the cluster angle beta selected always to yield an integer quotient when divided into 360^0, and also when divided into the segment fraction of a circular disc, i.e., 30^0, 45^0, 60^0, 90^0, 120^0, etc.

In the specific and preferred cases of:

Figure 1, disc diameter is 16 inches, the offset angle alpha is 10^0, each segment is 120^0 and contains 8 bar clusters, with a total of 24 bar clusters in the refiner filling, and with a cluster angle beta of 15^0; and

Figure 3, disc diameter is 26 inches, the offset angle alpha is 6^0, each segment is 60^0 and contains 8 bar clusters, with a total of 48 clusters in the refiner filling, and with a cluster angle beta of 7.5^0.

The schematic layout of Figure 4 includes a 34 inch diameter disc, with 8 segments of 6 clusters each, a cluster angle beta of 7.5^0 and a pumping angle alpha of 10^0.

A primary aspect of the invention is the laying out of a cluster envelope which must fit within the inner and outer perimeter of the active refining zone of the circular filling, and within the two more or less radial cluster edges 24 a-b which divide the entire circle into an integer number of clusters.

In the schematic of Figure 4, the active refining zone 26 is divided into 8 identical segments each defined by lines 30 tangent to an inner circle 32, and with each segment subdivided by tangent lines or cluster radials 24 a-b into 6 identical bar cluster envelopes 36. (The diameter of the inner circle 32 determines the pumping angle alpha by known geometric calculation). Each bar cluster envelope 36

is further defined by a chord 38 along the outer perimeter 20 between adjacent cluster radials 24a-24b, and by an inner line 40 parallel to outer chord 38 and passing through the intersection I of the inner perimeter 22 and one of the cluster radials 24a. In a finished refiner filling all blades and spacers will lie within the cluster envelope 36 generated in this manner.

The manufacturing method first prepares a bar set pattern or envelope in the form of a parallelogram. The bar set envelope receives a precise number of blades and spacers within the envelope's exterior dimensions for yielding two identical bar clusters when the envelope is cut into equal pieces. Every cluster 24 of the refiner filling is produced in this way.

An outline of adjacent bar set clusters 24 l-r appears in Figure 6 including oblique side edges 24a, 24b, outer chord lines 38, inner lines 40 and cut lines C-C.

The left-hand bar set cluster outline 24l of Figure 6 is re-positioned in Figure 7 alongside cluster 24r to form a bar set envelope or parallelogram 42. The bar set envelope 42 consists of a pair of bar clusters with parallel oblique side edges 24a, 24b, and with the clusters abutting each other along their cut edges C-C. The ends of the bar set envelope parallelogram are formed by chords 38 and by parallel lines 40. This arrangement is shown in Figures 6 and 7 in which it is seen that one cluster 24r is in correct operational position and the other cluster 24l is rotated 180^0 to form the parallelogram pattern. In Figure 6 representing the operating position of adjacent clusters 24l-r, cut edges C-C appear as the left edge of each cluster. In Figure 7, cut edges C-C abut and define the line along which the bar set of assembled bars and spacers is cut by suitable means. The bar set envelope 42 defines the basic manufacturing unit for assembling and temporarily attaching blades and spacers prior to final metallurgical or other suitable bonding. The bar set envelope also facilitates use of identical bars and identical spacers throughout the entire filling.

The blades 46 and spacer 48 are shown in Figure 5a-h and comprise three blades types, including a long or unnotched blade 46a, an end notched blade 46b and a center notched blade 46c.

It is very advantageous that each blade's inner end be tapered 50 as

shown in Figure 5, in order to prevent fibrous material from being stapled over the end of a blade positioned at inner perimeter of the active filler zone. Such stapling can eventually lead to plugging or otherwise interrupting the uniform flow of fibrous material into the active refining area. Accordingly, a taper is formed at the end of blade 46a, and also as defining margins of notches 49 of blades 46b and 46c since, after a bar set is cut in half, each tapered notch margin becomes a blade inner end as is apparent in Figures 8, 9 and 10.

Once the bar set cluster envelope 42 is defined and the desired blade and spacer widths have been selected, a precise number and length of blades and spacers are stacked to form a parallelogram of particular width, length and bar set angle theta as in Figure 8. The dimensions of the bar set are such that the bar set may be cut in half along line C-C to form two identical bar clusters.

In the specific example of Figure 8, blades 46 and spacers 48 are assembled alternately within the parallelogram. Blades with tapered ends 50 are put into position outside the barset cutting line C-C. Blades intersecting the cutting line are notched with the notch 49 occurring where the cutting line passes. This is shown in Figure 8 where the cutting line passes notches in blades 46b and 46c.

After the blades and spacers are assembled and temporarily or permanently bonded, the barset is cut along the dividing line C-C into identical bar clusters 24. As shown in Figure 9, after cutting, one of the bar set clusters is re-positioned by rotation of 180^0 for assembly into a refiner segment. The segments include bolt holes 52 (Figs 2, 3) for attachment to a refiner disc.

The method of manufacture proceeds as follows. The layout (Fig 4) of a refiner filling is established including outer 28 and inner 22 perimeter circles defining an active refiner zone 26. A pumping angle alpha and a cluster angle beta are selected (or known) for the refiner filling and located in the layout. A relatively small cluster angle results in a short outer chord 38 which is desirable. A core circle 32 tangent to the pumping angle oblique 24a is formed to which circle all additional oblique lines 24a and 24b are tangent. In the example shown in Figure 4, a cluster angle beta of 71/2^0 is selected. A pumping angle of approximately 10^0 is selected and the core circle 32 is drawn.

Next, the number of segments (8 in the example of Fig 4) is set and

defined by 8 equally spaced oblique lines 30. The number of clusters per segment is determined (6 in the example) by equally spaced oblique lines 24.

In the layout, a cluster envelope 36 is defined by adjacent obliques 24a-b, a chord 38 between the intersections of the obliques and the outer perimeter circle 28, and by an inner line 40 parallel to the chord and passing through the intersection I of the inner perimeter circle 22 and one oblique 24a.

A bar set envelope 42 (Figs 6 and 7) is defined by a pair of cluster envelopes 24l-r with one cluster 24r oriented as in Figure 3, and the other cluster envelope 24l rotated 180^0 to define a parallelogram with the one cluster envelope. That is, the left edges 24b of the cluster envelopes 24l-r seen in Figure 7 define a cutting line C-C along which the bar set is cut to form the cluster envelopes. The bar set envelope next receives blades and spacers sized in length and width to fit precisely within the envelope.

An assembly of blades and spacers appears in Figure 8, including end tapered blades, and prenotched blades with notches defined by tapered ends and with the notches situated in the cutting line. After assembly the blades and spacers are affixed to each other by means appropriate to the materials used. For example, blades and spacers may be metallurgically bonded entirely throughout the interconnecting surfaces of blades and spacers for the bar set, and then cut along the cutting line to form bar clusters. Alternatively, the bars and spacers maybe temporarily attached as by tack welding prior to cutting, and bonded after cutting.

Figure 10 illustrates the cut edge of a bar set cluster along line C-C. In this profile view the cut line diagonally intersects blades 46c through their notches, and diagonally through spacers 48. Blade 46a is not cut and terminates in tapered end 50.

Various changes may be made to the structure embodying the principles of the invention. The principles of the invention, while described in preferred embodiment of refiner disc segments, are also applicable to other configurations of refiner fillings. For example, the invention also has application to working surfaces of refiners in conical or other types of refiners.

The foregoing embodiments are set forth in an illustrative and not in a limiting sense. The scope of the invention is defined by the claims appended hereto.